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AN ASSESSMENT OF THE FORECASTING ACCURACY OF THE STRUCTURED ACCESSION PLANNING SYSTEM FOR OFFICERS (STRAP-O) MODEL

by

James Allen Frank

June 1993

Principal Advisor: Stephen L. Mehay
Associate Advisor: Thomas P. Moore

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This thesis evaluates the forecasting accuracy of the Structured Accession Planning system for Officers (STRAP-O) model. The vehicle for this examination is the implementation plan for the Aviation Continuation Pay (ACP) program. An important policy question to be addressed is whether the ACP bonus program will increase the continuation rate of mid-grade aviators sufficiently to fulfill department head requirements in the mid 90's? The design of the STRAP-O system and its components are explained and a synopsis of the ACP program is included. The methodology used for determining the accuracy of the STRAP-O model is outlined, as well as the results obtained by running STRAP-O. These results are compared to the results of a CNA study on the ACP program and to the actual number of ACP recipients in 1989. In addition, suggestions are made to assist in the creation of a personal computer version of the STRAP-O model that will replace the current mainframe version.

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AN ASSESSMENT OF THE FORECASTING ACCURACY OF THE STRUCTURED ACCESSION PLANNING SYSTEM FOR OFFICERS (STRAP-O) MODEL

by

James Allen Frank
Lieutenant, United States Navy
B.A., University of Florida, 1983

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Author: James C. Frank
James A. Frank

Approved by: Stephen L. Mehay
Stephen L. Mehay, Principal Advisor

Thomas P. Moore
Thomas P. Moore, Associate Advisor

David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

This thesis evaluates the forecasting accuracy of the Structured Accession Planning system for Officers (STRAP-O) model. The vehicle for this examination is the implementation plan for the Aviation Continuation Pay (ACP) program. An important policy question to be addressed is whether the ACP bonus program will increase the continuation rate of mid-grade aviators sufficiently to fulfill department head requirements in the mid 90's? The design of the STRAP-O system and its components are explained and a synopsis of the ACP program is included. The methodology used for determining the accuracy of the STRAP-O model is outlined, as well as the results obtained by running STRAP-O. These results are compared to the results of a CNA study on the ACP program and to the actual number of ACP recipients in 1989. In addition, suggestions are made to assist in the creation of a personal computer version of the STRAP-O model that will replace the current mainframe version.

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I. INTRODUCTION

A. OVERVIEW

With the massive changes that will take place in the military manpower system during the 1990's, strategic planning is assuming increased importance. However, because the Navy must answer to Congress on a daily basis, tactical (current) issues take up the majority of staff efforts in the Navy manpower planning community. Focusing solely on current issues can create serious future problems if the long-term implications of short-term policy decisions are not considered.

Putting out the daily "fires" is the major focus of planners in the office of the Assistant Chief of Naval Personnel for Military Personnel Policy and Career Progression (PERS-2). What is needed is a tool that not only assists in tactical manpower planning, but that also forecasts this tactical plan forward and projects the strategic, long-term implications. If possible, this capability should be combined in a single model.

Being blind to potential future "fires" that are created by current policies may perpetuate the need for last-minute "damage control." The ability to forecast personnel behavior due to changing manpower policies or fluctuations in civilian

economic conditions eases the job of the manpower planner by providing some early indications of potential problems.

B. OBJECTIVE

The tactical problem to be addressed in this thesis is the shortage of mid-grade aviators which is expected to occur in the early 1990's. This thesis unsuccessfully attempted to analyze a proposed solution to this problem. The Structured Accession Planning System for Officers (STRAP-O) model was used to forecast the retention effects of a new, increased bonus program called the Aviation Continuation Pay (ACP) bonus program. The ACP bonus program was instituted in 1989.

This analysis was originally attempted in a CNA study by Donald J. Cymrot, entitled "Implementation of the Aviation Continuation Pay (ACP) program" [Ref. 4]. The results of the CNA study indicated that shortages of mid-grade aviators would remain even if the ACP bonus program was established. On the other hand, the analysis in this thesis indicated that most shortages could be overcome with the ACP bonus program. The results from the first 3 years of the ACP bonus program support the CNA conclusions.

Chapter II of this thesis provides an overview of the STRAP-O model. Chapter III provides an overview of Cymrot's original evaluation of the Aviation Continuation Pay (ACP) program, and summarizes his results. Chapter IV outlines the methodology of this thesis and compares the results of this thesis to those of Cymrot. The conclusions of this thesis are

presented in Chapter V. Recommendations for the current upgrade and creation of a PC-based version of the STRAP-O model are offered.

Among the issues this thesis proposes to address is the following especially important issue. Although STRAP-O was designed as a strategic planning tool, an important question is whether it can also be used tactically. That is, can STRAP-O be modified to solve short-term problems? If STRAP-O can either be modified, or "tricked," into a short-term mode, then PERS-2 manpower planners would have a tool to help them put out "fires" today and, at the same time, make forecasts of the long-term ramifications of different short term scenarios. This would assist manpower planners in stabilizing manpower policies and obviate the need for last minute, crisis management.

A stable manpower system positively impacts readiness and reduces the total cost of manning the Navy. For example, a stable system smoothes the training process because the true training requirements will be accurately known. As people flow through the system more evenly with fewer year group reassignments, uncertainty in the promotion system is lessened.

This should increase morale and lead to higher retention. Higher retention means lower training requirements, which reduces training outlays. Higher retention also means a more experienced force, which makes fewer mistakes in the form of

crashed aircraft and damaged ships. All of these will provide potentially significant savings to the Navy.

II. THE STRAT-O MODEL BACKGROUND

A. OFFICER PLANNING PROCESS OVERVIEW

Officer manpower plans in the Navy are developed for individual communities (Surface Warfare, Aviation, etc.). These separate community plans are passed from the officer community managers to the total officer strength planner who compiles each individual plan to make the total Navy plan. This plan is then sent to PERS-2 (Headed by a one star admiral) for approval. The plan is then forwarded to the Chief of Naval PERSonnel (a three star admiral) and to the various resource sponsors (Surface Warfare, Aviation, etc.) for review. The plan is then sent back down to the officer for any community managers modifications based on this review. This process is repeated until all the separate plans add together into a coherent workable all-Navy plan. This iteration process is both time-consuming and cumbersome.

B. NAVY OFFICER PERSONNEL PLANNING SYSTEM (NOPPS)

The total Navy plan is compiled using the Navy Officer Personnel Planning System (NOPPS). NOPPS is used by the Officer Plans and Career Management Branch (PERS-21) to develop the overall strength plan, monitor the strength plan execution, and respond to strength queries from outside sources. NOPPS calculates average strengths and predicts end strength for the current, budget and FYDP (Future Years

Defense Plan) years. NOPPS does not have a sophisticated method of forecasting. The loss rates used by NOPPS are strictly historical and forecasts are done in a naive fashion. NOPPS also provides a means of creating and analyzing officer strength plans and computes DOPMA grade ceilings. Similar to a large spreadsheet program, NOPPS is used to gather and store the large amounts of information used in preparing the officer strength and budget plans. [Ref. 5:p. 5-1]

NOPPS is a collection of menu-driven systems written in APL and run on a personal computer. All of the information contained within NOPPS is reconciled each month for accuracy with the Officer Master File to keep actual inventory levels current. [Ref. 5:p. 5-1]

C. STRUCTURED ACCESSION PLANNING SYSTEM FOR OFFICERS (STRAP-O)

The Structured Accession Planning System for Officers (STRAP-O) is a set of linked, mainframe computer models. The purpose of these models is to assist the Navy in strategic manpower planning. An initial version of STRAP-O, which deals only with the Unrestricted Line (URL) communities, was installed at the office of the Deputy Chief of Naval Operations (PERS-2) in September 1981. A total force version, which included all Navy Officers, came on line in March 1982. The latest version has been modified several times, with the most notable change the addition of a "user-friendly" inter-

face that prompts the user for inputs and automatically manages the data base.

The idea and focus of STRAP-O is to answer "what if" questions concerning manpower policies and plans by community, as well as questions about how the communities interact in creating the total Navy plan. The total Navy plan includes all of the community-specific needs as well as training requirements, personnel throughput, and support billets. STRAP-O determines if these manpower policies and community plans are feasible by forecasting seven years into the future the annual stocks of personnel by community, length of service (LOS), and pay grade. It also gives the stocks for the intervening years and can, on request, forecast out to 100 years in the future to display the "steady state" force structure.

STRAP-O can determine if and how desired force levels can be reached. This is done using expected or mandated rates of attrition and promotion. At the same time, STRAP-O can determine the number of accessions from each commissioning source required to meet the intermediate stages of a desired force end strength.

STRAP-O considers Defense Officer PERSonnel Management Act (DOPMA) restrictions, promotion policies, pay-grade targets, and manual overrides when developing a feasible plan. The user can create an almost unlimited number of scenarios and

forecast the long-range implications of each. Some examples of uses of the model are listed below:

1. A desired force end strength can be defined (as well as the desired size and the time horizon for achieving the goal), and based on this STRAP-O will determine required accessions and promotion policies, given expected loss rates;

2. Accession requirements can be defined and STRAP-O will determine the future end strength;

3. STRAP-O will choose the appropriate promotion zones or promotion opportunities for a given force structure. Either of these can be given and the implications forecasted. For example, will the specified policy variables generate "choke points" or shortages in the flow of personnel through the system?

4. STRAP-O can be used to forecast the effect of pay changes on the loss rates in the different communities;

5. The best mix of officers from different accession sources can be determined with STRAP-O by considering the retention history of these various commissioning sources.

The scenarios listed above are only a few of the possible situations that can be examined through STRAP-O, alone or sometimes in combination with each other.

D. DATA INPUTS

The starting data required by the STRAP-O system is the stock of active duty Navy officers onboard at the beginning of the fiscal year. These inventories are updated by the Navy PERSonnel Research and Development Center (NPRDC) from the Navy Master Loss File once a year. STRAP-O also requires a set of manpower requirements that describe the personnel implications of alternative Navy missions. [Ref. 1:p. 4] STRAP-O can represent manpower requirements as "true"

requirements where the end strength under consideration is solved only for the billets authorized by DOPMA. These requirements are supplied by the Navy Manpower System (NAMPS). Requirements can also be determined as a function of an "objective force." Objective force requirements are those requirements that allow for steady manpower throughput, where all communities receive their required number of personnel. This is an "ideal" force structure that ignores legal and budgetary personnel constraints.

Manpower requirements fall into two categories: 1) structured spaces, and 2) unstructured spaces. Structured spaces are operational and support billets--the jobs directly associated with accomplishing Navy missions. Also included in this category are managerial billets (designators 1050s/1000s) that can be filled by any officer, and billets that can only be filled by an officer from a specific warfare community (e.g., pilot). Unstructured spaces are the billets for students, transients, and patients, which are not required in the direct accomplishment of the Navy's missions.

The STRAP-O model automatically aggregates and apportions these requirements and forms the goals that it seeks to achieve [Ref. 1:p. 4]. The stocks of Navy personnel are disaggregated into 31 communities[1], 9 pay grades (O1-O6 with three fail-select grades, O3F, O4F, and O5F), and 31 LOS cells. This disaggregation generates 8,649 matrix elements

[1]Officer communities are listed in Appendix A.

that must be determined. STRAP-O solves for all of these elements simultaneously in determining the manpower configuration needed to sustain desired personnel policies such as consistent promotion flow points and opportunities.

E. STRAP-O SYSTEM OPERATION

The STRAP-O model is made up of four separate modules that work in concert. Figure 1 shows these modules and how they interact:

1. Officer Goals (OGOALS).
2. Accession Into Designators (AIDS).
3. Officer Force Projection Model (OPRO).
4. Officer Retention Forecasting Model (ORFM).

OGOALS is the "front-end" of the STRAP-O model and provides AIDS and OPRO with a common set of strength goals. OGOALS performs the following three-step process for the AIDS module. First, the warfare-specific structured spaces are divided into the various communities by experience level (defined by contiguous length of service cells), the dimension employed by AIDS. Then the remainder of the structured spaces, the managerial billets, are allocated among the 31 specific communities and then converted as above. Finally, the unstructured spaces (manpower overhead billets) are determined as a function of the size and configuration of the structured spaces and applied to each community.

If the user were to supply only total officer strength requirements, OGOALS, working backwards, would estimate the

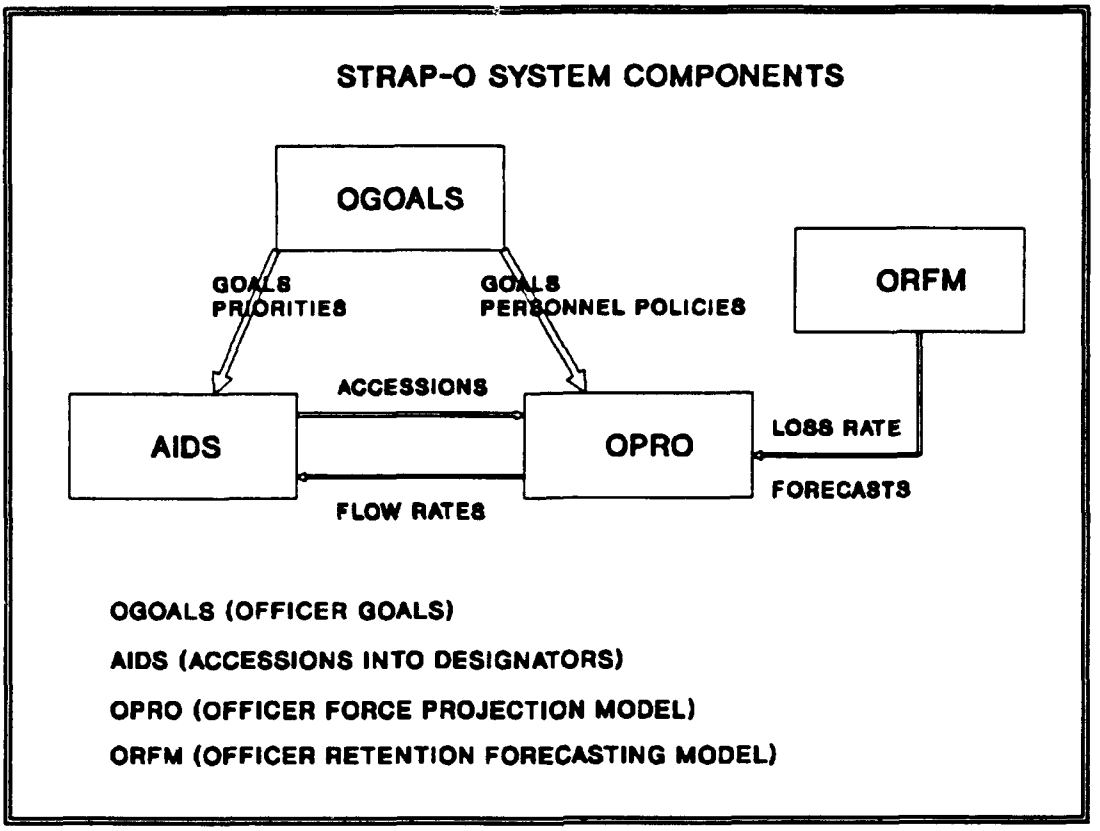

Figure 1. Flow diagram of the STRAP-O system components

portion of that force needed for overhead spaces and then divide the remaining structured spaces among the various communities. For OPRO, the OGOALS module produces total strength and specific grade goals from the same requirements set used for AIDS. This ensures that the solutions from both the AIDS and OPRO modules are moving toward consistent targets [Ref. 1:p. 4]. The OGOALS targets supplied to AIDS and/or OPRO can be defined by the user as true requirements or as objective force requirements.

AIDS is a linear programming model that determines the optimal number of officer accessions each year from each commissioning source to achieve future force goals [Ref. 1:p.

2]. It has been observed that officers from different commissioning sources and in different specialties display different retention behaviors [Ref. 1:p. 2]. These differing behaviors will have different effects on the Navy's ability to meet its needs. Commissioning programs also differ in other ways important for planning purposes: cost, training capacity (the number of personnel that can trained with a given set of resources), and length of training [Ref. 1:p. 3].

The AIDS module simultaneously considers all three of these factors by community and for the total Navy. The optimal mixes are considered and projected forward by the OPRO module. AIDS can also be given priorities: for example, requirements of the aviation and submarine community may be deemed more important than those of the surface warfare community.

The OPRO model forecasts personnel flow behavior of officers as they are gained or lost to the system, promoted, or "aged." By imposing management intentions concerning accessions and promotion policy, and estimating the expected losses, OPRO can forecast and summarize the personnel flows in terms of continuation rates, which are then passed to AIDS [Ref. 1:p. 3].

The primary "engines" of STRAP-O, as they were initially designed, are the AIDS and OPRO modules. In achieving a desired force structure, these two modules can simultaneously consider the accession, loss, and promotion polices under

consideration. Alternatively, each module can be run separately. If OPRO and AIDS are run together, OPRO determines losses, and promotes and ages the force; it then sends this information to AIDS. AIDS, in turn, gives back accession requirements. This is an iteration process that continues until AIDS and OPRO are working as a system and a steady throughput of personnel is attained. If OPRO is run separately it assumes a set of manually input default values for the number of accessions and simply ages the force. In this way no modifications to accessions, up or down, are made to adjust for shortfalls or surpluses in the flow of personnel.

The mechanics of the OPRO model are those of a "naive" model.[2] It takes the forecasted transition matrix and projects the force forward. Promotion rates, lateral transfers, and accession rates are input by the user and/or AIDS. However, the last critical flow, loss rates, are determined in the officer retention forecasting module (ORFM).

ORFM's purpose is to produce a set of loss rate forecasts for each of the 31 STRAP-O communities over a 7-year time horizon. [Ref. 5:p. 6] ORFM uses time-series techniques and econometric methods to forecast future loss rates. Since retention behavior for each sub-community is different with

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[2]A naive model is one that forecasts strictly on the basis of historical rates. No attempt is made to adjust the forecast rates as a result of changes in economic or civilian employment conditions or Navy policies.

respect to changes in compensation, loss rates are calculated independently for each sub-community. ORFM estimates the changes in loss behavior that are expected to occur in each specific community as a result of changes in compensation policies. The model determines an officer's expected life-stream earnings from the decision to remain in the military as compared to the earnings stream that would result from a decision to return to civilian life. By mathematically relating the two earnings streams to the current and historical loss rates, estimates of future loss rates can be made, given the earnings streams implied by alternative compensation policies. [Ref. 1:p. 3]

ORFM uses two techniques to forecast loss rates: one is a time-series projection, the other an econometric model. The time-series technique involves historical weighting (HW) and is non-behavioral. The behavioral, econometric model is a cost-of-leaving (COL) model, and is a variant of the annualized cost-of-leaving (ACOL) model, developed by Warner and Goldberg (1979). The HW technique weights the actual historical loss rates, using the data available, to determine the forecast loss rate. The user can enter his own specific weights with the only restriction being that they must sum to one. With no user input, STRAP-O uses a default geometric weighting scheme to determine the weights placed on the individual years' historical loss rates. The weighting scheme involves $(1/2)^i$ where i is the number of years between the

present and the past year. For example, to determine the forecasted loss rate for a specific community for 1990 with five years of historical data available, the equation is:

$$\bar{L}_{1990} = w_1(L_{1989}) + w_2(L_{1988}) + w_3(L_{1987}) + w_4(L_{1986}) + w_5(L_{1985})$$

Where: $\bar{L}_{1990}$ = Forecasted 1990 loss rate
L_{1989} = Actual 1989 loss rate
.
.
w_1 = Weight applied to the most recent actual for loss rate
.

To make the weights sum to 1.0 a residual amount equal to the weight of the last year (1985) must be distributed across all five years' weights. In the above example .0313 is divided by 5 and added to each weight.

$$w_{i=1\text{-}5} = (1/2)^i + ((1/2)^5)/5$$

$w_1 = .5000 + (.0313/5) = .5063$
$w_2 = .2500 + (.0313/5) = .2563$
$w_3 = .1250 + (.0313/5) = .1313$
$w_4 = .0625 + (.0313/5) = .0688$
$w_5 = .0313 + (.0313/5) = .0376$
1.000

This weighted average historical loss rate is then adjusted, by a logistic econometric COL model, for any expected or projected real pay changes (pay is calculated net of inflation). If no pay change is entered, then the model assumes a cost of living increase equal to inflation to keep the absolute difference between military and civilian pay constant.

Once future loss rates are forecasted, they are subjected to a "wear-off" function that brings the loss rate back to a baseline rate. The individual historical loss rates for each year form a cyclical pattern that fluctuates with the economy. Loss rates are higher when the economy is strong, and lower

when the economy is weak. From these cyclical loss rates, a baseline loss rate is generated. Currently, the baseline is a simple unweighted average of all historical loss rates AOM 1969 to the present.

ORFM implements this wear-off function for two reasons. The first reason is related to the increasing uncertainty over time associated with the forecasts.

The second reason is associated with the "absolute pay" hypothesis. Because uncertainty is relatively high, ORFM employs a conservative strategy that forces its forecasts toward a historical average.

Some of the more important variables that ultimately determine the number of losses include civilian and military pay and benefit levels, civilian unemployment rates, promotion opportunities, and sea-shore rotation requirements. These variables are difficult to forecast, and their influence on loss behavior is difficult to estimate. Because of this, the assumption that loss rates tend to some baseline average is adopted.

The second reason a conservative strategy is employed deals with the "absolute pay" hypothesis, which assumes that military personnel are less concerned with their absolute level of income than their income relative to their civilian counterparts. Also, it is assumed that military personnel expect a certain level of real growth in their incomes. This belief is based primarily upon the recent history of real

income growth. If a growth rate in real income is not sustained, loss rates will tend to rise even if the relative level of income is held constant. [Ref. 5:p. 7]

The above are the reasons a wear-off function is employed. The procedure to calculate the wear-off of loss rates for forecast years 2 through 7 is as follows. For each Length of Service (LOS) and Paygrade cell, a baseline loss rate is calculated from the trend line of the historical data available. The first year forecast is the weighted average of the previous years' loss rates, adjusted for any pay changes, as discussed above. At some point in years 2 through 7, the loss rate forecast migrates to the baseline loss rate. The speed at which the forecast rate returns to the baseline is based on the coefficient of variation and the mean time between "crossover" of the historical loss rates. The coefficient of variation is determined by dividing the standard deviation of the historical loss rates by their mean. The larger the coefficient, the greater the volatility of the loss rates, and the shorter the wear-off period [Ref. 5:p. 8].

The historical loss rates are cyclical, fluctuating between a high and a low with respect to the baseline rate. The mean time to crossover is calculated as the average time, in years, between movements from below the baseline to above the baseline, or vice versa. This average is computed from the historical data about crossovers. The shorter the mean time to crossover the quicker the forecast loss rate returns

to the baseline, with the opposite also being true. [Ref. 5:p. 8]

F. MODEL VERIFICATION/VALIDATION

In 1986 NPRDC performed a verification of STRAP-O for a five-year test period, FY81-85. The actual FY81-85 loss rates, gains, and promotion policies were entered in order to verify the mechanics of the model and to assess the forecasting errors it produced.

It was discovered that the model predicts accurately for the total Navy and for each major community, but showed substantial errors in the smaller sub-groups such as pilots, Naval flight officers (NFO), and nurses. These errors were attributed in part to the difficulty in modeling lateral transfers, the policies for which change yearly. Year group designations were also found to be inaccurate, in part because they also changed regularly. Both of these factors accounted for the inaccuracies in the smaller groups.

A validation was also performed for the FY81-85 test period to ascertain STRAP-O's capability to forecast losses and project inventories compared to the actual execution over this time period. Six different loss forecasting methodologies were analyzed to determine which where the most effective in forecasting personnel behavior:

1. Naive method with wear-off
2. Naive method without wear-off
3. Weighted method with wear-off

4. Weighted method without wear-off
5. ACOL with wear-off
6. ACOL without wear-off

For the ACOL method without wear-off, loss rates in the years subsequent to the initial pay change are still increased or decreased for additional pay changes.

The validation study indicated that the ACOL method without the wear-off function proved best for the total URL community, while the ACOL method with the wear-off function minimized the forecasting inaccuracies for Restricted Line (RL), Staff, and Limited Duty Officer (LDO) communities. It was concluded that the ACOL method holds the greatest promise. In general, any technique employing wear-off was superior to those not using wear-off for RL/Staff/LDO communities. [Ref. 6:p. 22]

The forecast error rates, using the ACOL methods, were less than six percent for 26 of the 31 communities. Those communities where the error rate exceeded six percent generally had large numbers of lateral transfers and/or year group designation changes. Because they can have large fluctuations from year to year, future lateral transfers and designation changes are difficult to anticipate and to predict. Prior to this validation, STRAP-O forecasted inventories with a year group designation. In a year group designation stocks of personnel are grouped by the fiscal year they are accessed. This creates forecast errors since

personnel will change year groups if promoted early or late, or if they laterally change from one community to another. With a year group format, an individual's actual length of service is not the dimension being modeled. STRAP-O was changed to use an LOS scheme after the errors using the year group designation format were discovered. [Ref. 6:p. 24]

G. MODEL USAGE

The STRAP-O model resides at the Argonne National Laboratories in Chicago, Il. and is linked to the Bureau of Naval Personnel in Washington D.C. via a modem connection. Only the personnel from PERS-212, the Officer Plans branch, currently use the model, and only one person in the branch uses it actively.

Furthermore, from August 90 through April 91 there have been only four requests from outside the PERS-21 shop for STRAP-O information. PERS-212 attributes this lack of use to the following: 1) the other potential users of the model do not really know what it can do for them; 2) the yearly forecast time horizon is not useful to the many people who must deal with short-term issues; 3) as the year progresses, the data on personnel stocks become outdated; and 4) it can, and normally does, take 24 hours to receive STRAP-O output.

A recent STRAP-O request provides, however, an example of the model's value. A new community is being formed called acquisition and the Navy would like this community to eventually have 399 Captains (O6's). A major issue involves

the difficulty and cost of establishing this community. STRAP-O is being used to determine the required structure and accessions of LT's and LCDR's needed to support this community, and how this new community will affect the total Navy plan given the restrictions of DOPMA.

III. THE AVIATION CONTINUATION PAY PROGRAM

This thesis uses the STRAP-O model to forecast the retention behavior of aviators that would result from the implementation of the Aviation Continuation Pay (ACP) Program. These forecasts are compared to forecasts made in an earlier study by the Center for Naval Analysis (CNA), entitled "Implementation of the Aviation Continuation Pay (ACP) Program." [Ref. 4] This chapter summarizes the CNA study, outlines the reasons why the ACP program is replacing the Aviation Officer Continuation Pay (AOCP) program, discusses the methodology used by CNA to determine the effectiveness of the ACP program, and discusses the forecasting results of the CNA study.

A. DESCRIPTION AND SUMMARY OF THE AOCP AND ACP PROGRAMS

Throughout the 1980's there was a persistent, critical shortage of mid-grade (CAT II) aviators.[3] This mid-grade period begins at the end of the minimum service requirement that is incurred upon graduation from flight school. CAT II aviators are critical because they are required to fill the department head billets (senior, experienced aviator positions) in aviation squadrons. The AOCP and ACP programs

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[3]Defined as senior lieutenants and lieutenant commanders who are between their sixth and eleventh year of service (YOS), and who have completed their initial squadron tour.

were designed to help retain these aviators. Monetary incentives such as the AOCP program have reduced shortages, but the current AOCP program, instituted in 1981, was proving to be too restrictive and insufficient to eliminate the persistent shortages. [Ref. 4:p. 1]

Under the AOCP program, personnel in eligible aviator communities[4] (those with shortages) were entitled to an annual bonus of $6,000. The bonus was aimed at both pilots and naval flight officers (NFO's) with contract lengths of either two, three, or six years. One of the major problems with the AOCP program was the fact that the contracts were short enough to allow many aviators who accepted bonuses to leave the Navy before serving a department head tour. Another problem was the inflexibility in allocating bonus payments: aviators received either a $6,000/year bonus or nothing. Also, $6,000/year is not a very large bonus considering the opportunities for civilian aviators.

The ACP program differs from the AOCP program in several ways. First the maximum allowable payment per year for pilots was increased to $12,000, while a fixed $4,000/yr payment was available to NFOs. Also the member has the option of taking 50 percent of the total bonus amount in the first payment and the remaining 50 percent spread equally over the length of the contract. The Navy can pay lesser amounts to aviators in

[4]The subcommunities and associated aircraft types are listed in Appendix B.

communities with smaller shortages, and greater amounts to aviators in communities with larger shortages, so long as the annual maximum of $12,000 is not exceeded. The length of a contract under ACP was increased to cover from the point an individual accepts the bonus through YOS 14. This ensures that these aviators will stay in the service long enough to complete a department head tour. Currently, one- and two-year contracts are still available under the ACP program and are targeted primarily at training command instructors. This is to entice them to remain on active duty until the end of their initial shore tour so that training command needs are met. However, these shorter contract lengths will be phased out since the minimum service requirement incurred at the completion of flight training has been lengthened from four years to seven years. Finally, note that only a total of $30 million per year can be spent on the ACP program. This thesis focuses on how best to implement this new program to meet expected future shortfalls.

B. METHODOLOGY OF THE CNA STUDY

CNA's analysis of the ACP program focused on the manner in which the cumulative continuation rate (CCR) is calculated. The CCR for the ACP represents the percentage of aviators who are currently eligible to leave the Navy that the Navy must try to retain through YOS 11 in order to fulfill department head requirements (number of department head billets divided by the stocks of personnel between YOS 6 and 11).

The CCR for the AOCP was calculated by looking at the entire inventory of aviators by community. Included in this rate are all aviators from YOS 3 to YOS 14. (Prior to YOS 3 is flight school.)

The CNA study only considered aviators eligible to leave military service in determining the ACP continuation rates. Therefore, the CNA study only examined the stock of aviators in the YOS range 6 to 11. Calculated this way, the CCR reflects the continuation rate that must be achieved from within the group of aviators eligible to leave the military to meet future department head requirements. The objective of the ACP program is to increase the continuation rate of aviators in this group.

CNA's methodology employed five basic steps: [Ref. 4:p. 3]

1. It determined the required overall continuation rate from YOS 6 to YOS 11 by taking the ratio of the annual requirements for department heads (at YOS 11) to the average inventory (at YOS 6);

2. It adjusted the baseline (current) continuation rate for any forecasted changes in conditions such as the number of pilots hired by civilian airlines;

3. It subtracted the forecasted baseline continuation rate from the required continued rate to determine the percentage-point change in the continuation rate needed to meet requirements;

4. It used statistical estimates of the relationship between pay and retention, using data collected from the AOCP, to calculate the cost of increasing the continuation rate by 1 percentage-point. Multiply this cost times the percentage-point change in the continuation rate needed to meet requirements to determine the required additional cost;

5. Finally, the additional estimated increase in the bonus was added to the current bonus to determine the total required bonus;

The implementation of the above methodology required detailed information about the future supply and demand for aviators. [Ref. 4:p. 4] The data requirements are listed below:

a. Requirements, in the early 1990s, by subcommunity and designator for department heads and other lieutenant commanders (CAT II's);

b. Inventories of year groups approaching bonus eligibility;

c. A baseline (current) continuation rate;

d. Statistical estimates of the effect of pay and other factors on aviation retention;Each of these data requirements are discussed below:

1. Requirements

The purpose of the ACP program is to retain enough aviators to fulfill CAT II requirements. These requirements are determined by the Manpower and Training Branch of the Assistant Chief of Naval Operations (Air Warfare, N-889) and are listed in CAT I/II Aircrew Experience Mix and Required Cumulative Continuation Rates by Subcommunity, Naval Aviation Management Series, Revision 4-88, 15 July 1988.

Several modifications are made to the numbers from this document to facilitate the bonus determinations: 1) first, all bonus takers may not be promoted and some may not be qualified to fill a department head billet [Ref. 4:p. 5] 2) therefore, requirements are increased ten percent to allow for a department head selection rate of 90 percent. This

TABLE 1. AVERAGE ANNUAL CAT II BILLET REQUIREMENTS BY SUBCOMMUNITY FOR PILOTS AND NFO'S

Subcommunity	Pilots	NFO's
VAL/VFA	53.1	n/a
VAM	21.9	20.0
VF	32.1	39.5
VAQ	11.2	32.9
VS	15.7	24.7
VQ JET	a	7.6
VP	99.5	51.6
VQ PROP	b	8.9
VQ TAC	b	15.6
VAW	13.4	24.6
HSL/HC	121.0	n/a
HS/HM	51.4	n/a

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program* [Ref. 4]

a. Combined with VS pilots.
b. Combined with VP pilots.

selectivity provides the required number of future department heads plus 10 percent for a quality screen. Some pilot subcommunities are combined in the analysis of requirements and inventories. The combined subcommunities are: (a) VS and VQ JET; (b) VP, VQ TAC, and VQ PROP; (c) HS and HM; and (d) HSL2, HSL60, and HC. Combining subcommunities implies that pilots in one of the subcommunities can be retrained and used in another subcommunity as necessary. [Ref. 4:p. 6] Third, in the VP communities, 60 percent of the CAT II requirements

are filled by pilots rather than NFOs. According to the Manpower and Training Branch of the Assistant Chief of Naval Operations (Air Warfare, N-889) the VP billets for CAT IIs are divided equally between pilots and NFOs. However, the future goal the for CAT II requirements is that 60 percent are filled by pilots. The annual requirements used in determining the implementation plan are shown in Table 1.

2. Inventories

TABLE 2. AVERAGE YEAR GROUP INVENTORY, AS OF SEPTEMBER, 1988, FOR PILOTS AND NFO'S IN YEAR GROUPS 1982-84

Subcommunity	Pilots	NFO's
VAL/VFA	81.0	n/a
VAM	36.3	43.3
VF	56.7	62.3
VAQ	13.7	44.7
VS	43.7	58.0
VQ JET	a	12.7
VP	105.7	121.0
VQ PROP	b	13.7
VQ TAC	b	15.0
VAW	28.0	38.7
HSL/HC	155.0	n/a
HS/HM	64.4	n/a

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program* [Ref. 4:p. 7]

a. Combined with VS pilots.
b. Combined with VP pilots.

Inventories are based on year groups, which roughly correspond to years of service. [Ref. 4:p. 7] The size of each year group varies widely, so using the inventory from a single year would cause wild fluctuations in bonus amounts. Also, in about 1993, the first cohort of aviators eligible for the ACP program will begin filling department head billets. Individuals from year groups 1982-84 will be used to fill these billets. Thus, the average inventory of these three year groups represents a practical and realistic approximation to represent the available stocks of personnel. These stocks were determined as of the end of fiscal year 1988. Table 2 shows the average inventories for year groups 1982 through 1984 [Ref. 4:p. 7].

3. Continuation Rates

The baseline overall continuation rate is an estimate of the probability that an aviator at YOS 6 will survive to YOS 11 under current conditions (including the current AOCP bonus effects on continuation). The standard methodology used to determine the baseline continuation rate is to multiply the continuation rates for the populations in each length of service (LOS) cell (those between YOS 6 and YOS 11) for that year. The calculation for the CCR is:

$$CCR = \prod_{n=6}^{11} CR_{LOS_n}$$

Where: $CR_{LOS\ n}$ = Continuation rate to LOS cell n from LOS cell n-1.

The continuation rate for FY 88 is determined from the remaining populations of year groups 1977 through 1982 in FY 88 (i.e., LOS 6 is YG 82, LOS 7 is YG 81, LOS 8 is YG 80, LOS 9 is YG 79, LOS 10 is YG 78, LOS 11 is YG 77).

With the change from AOCP to ACP, there is an important institutional change. Under AOCP, aviators at YOS 6 or 7 could take a 3- or 4-year contract and still leave before completing YOS 11 [Ref. 4:p. 9]. In FY 84 a number of jet pilots took a four-year bonus and when they completed this

TABLE 3. REQUIRED CONTINUATION RATES OF PILOTS AND NFO'S BY SUBCOMMUNITY (IN PERCENT)

Subcommunity	Pilots	NFO's
VAL/VFA	65.5	n/a
VAM	60.3	46.2
VF	56.7	62.7
VAQ	81.9	73.6
VS	36.1	42.1
VQ JET	a	60.0
VP	48.4	42.1
VQ PROP	b	65.3
VQ TAC	b	99.0+
VAW	47.8	63.5
HSL/HC	78.1	n/a
HS/HM	73.4	n/a

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program* [Ref. 4]

a. Combined with VS pilots.
b. Combined with VP pilots.

obligation in FY 88, left the Navy prior to serving in a department head billet. Under the ACP program, this cannot occur because aviators are obligated through LOS 14 [Ref. 4:p. 9].

In devising the ACP implementation plan, a modified form of the computation of the CCR, which accounts for the differences between the AOCP and ACP programs, replaces the standard CCR methodology. The modified CCR is 90 percent of

TABLE 4. ACTUAL AND MODIFIED CCR'S BY SUBCOMMUNITY FOR PILOTS AND NFO'S

	Pilots		NFO's	
Subcommunity	Actual	Modified	Actual	Modified
VAL/VFA	32.8	49.1	n/a	n/a
VAM	27.4	37.0	73.7	73.7
VF	24.9	40.8	50.0	63.3
VAQ	19.2	34.6	74.7	74.7
VS	19.3	23.2	63.3	74.0
VQ JET	27.0	40.7	66.0	79.9
VP	26.6	35.3	61.3	66.8
VQ PROP	25.0	33.9	47.4	51.3
VQ TAC	25.0	29.3	59.6	79.7
VAW	18.9	27.3	59.6	62.2
HSL/HC	53.0	57.8	n/a	n/a
HS/HM	54.3	67.3	n/a	n/a

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program* [Ref. 4]

a. Combined with VS pilots.
b. Combined with VP pilots.

the product of the continuation rates at YOS 6 through YOS 8 in FY 88. The calculation for the Modified CCR is:

$$\text{Modified CCR} = 0.90 * (CR_{LOS\ 6} * CR_{LOS\ 7} * CR_{LOS\ 8})$$

Where: $CR_{LOS\ 6}$ = Continuation rate from LOS 5 to LOS 6
$CR_{LOS\ 7}$ = Continuation rate from LOS 6 to LOS 7
$CR_{LOS\ 8}$ = Continuation rate from LOS 7 to LOS 8

The underlying assumption in calculating the modified CCR is that the decision to take an ACP contract is made sometime between LOS 6 and LOS 8. The modified CCR accounts for only 90 percent of continuation beyond this initial decision point to account for other types of attrition due to factors such as accidents, groundings, and lateral transfers. Also, the modified CCR (from the 6 to 8 LOS point) cannot be lower than the actual CCR (from the 6 to 11 LOS point).[5] If the actual CCR is lower than the modified CCR, the modified CCR is set equal to the actual CCR [Ref. 4:p. 10]. Table 3 shows the cumulative continuation rates of pilots and NFO's necessary to meet requirements. Table 4 shows the actual and modified CCRs for each subcommunity determined by CNA as of 1988.

4. Statistical Estimates

The relationship between bonuses, pay, other economic factors, and continuation rates has been estimated using data collected from the AOCP program. [Ref. 4:p. 11] A logit econometric (Annualized Cost-of-Leaving) model was used by CNA to estimate the effect of bonuses on the continuation rate. The estimated logit coefficients are shown in Table 5. These coefficients do not directly indicate the effect of the

[5]By "Actual CCR" we mean the CCR estimate computed as described at the start of this section on continuation rates.

TABLE 5. ESTIMATED LOGIT COEFFICIENTS USED TO FORECAST ACP BONUSES EFFECTS ON CONTINUATION RATES

Variable	Pilots	NFO's
Milciv Pay		
Jet	.019	.005
Prop	.016	.004
Helo	.015	n/a
Civilian Hires		
Jet	-.054	-.013
Prop	-.067	-.013
Helo	-.026	n/a
Unemployment Rate		
Jet	.025	.000
Prop	.029	.000
Helo	.076	n/a

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program*

variable on the continuation rate but instead indicate the change in the continuation rate resulting from a $1,000 increase in pay. The three basic variables are: relative military and civilian pay (Milciv Pay), civilian hiring rates,[6] and the annual unemployment rate of males age 20 and over. Through the use of interactive dummy variables, the separate effect of each explanatory variable on continuation is estimated for each of the three classes of aircraft. The

[6]For the analysis for Navy pilots, CNA used the rate at which domestic airlines were hiring new pilots. For the analysis for NFO's CNA used the rate at which civilian firms were hiring engineers of all types.

table shows the combined effect of the basic variable and the interactive dummy variable for the specific aircraft type [Ref. 4:p. 11].

5. Forecasts

A major source of uncertainty in this methodology is the future economic condition. An unexpected contraction or expansion of civilian employment could lead to underestimates or overestimates of separation behavior. Planners need to monitor economic conditions and be prepared to change bonus levels when there are major changes in conditions. [Ref. 4:p. 14] Although the statistical estimates shown in Table 5 make it possible to adjust the baseline continuation rates for changes in economic conditions, they assume a relatively stable environment. Recognizing these limitations, the following predictions of ACP effectiveness were made by CNA.

In general, given the size of the coefficients of the Milciv variable, pilots are more sensitive to pay changes than NFO's, and Jet pilots are slightly more sensitive to pay changes than Prop or Helo pilots. The less sensitive that continuation rates are to changes in pay, the more expensive it is to fix. Other things being equal, NFO bonuses would have to be about four times as large as pilot bonuses to have the same effect on the continuation rate. The relatively high cost of increasing NFO continuation makes it impractical to attack NFO shortages with bonuses. (Bonuses are offered to NFOs in communities with shortages because both pilot and NFO

face the same risks and to offer a bonus only to pilots would create morale problems). Other actions are therefore required to deal with NFO shortages. [Ref. 4:p. 12]

Given the above inferences about the effects of a bonus on aviator retention, an allocation rule was developed for determining the award levels for the various subcommunities. The rule takes into account the relative shortages between the subcommunities, and can be stated as follows:

> For any pairwise comparison of subcommunities, the one with the larger projected shortage (after accounting for the bonus) receives the larger bonuses. [Ref. 4:p. 19]

Table 6 shows the bonus amounts for each year of obligation by subcommunity for pilots and NFO's (determined by the above allocation rule) that were used in projecting the number of bonus takers in CNA's study. The variability in bonus payments (varying the bonus amount given to different aviation subcommunities based on actual shortages) will provide better future estimates of the pay elasticity[7] of aviators.

Column 2 of Table 7 shows the number of ACP contracts predicted by the CNA study, and Column 1 show the number actually attained in FY 1989 while Column 3 shows the percent error in CNA's predictions.

The large increase in the bonuses available in some subcommunities under the ACP bonus program is outside the range of experience with previous bonus programs (since some

[7]The pay elasticity in this study is the ratio of the percent change in the continuation rate for a one percent change in the bonus amount.

TABLE 6. SUGGESTED ANNUAL AWARD LEVELS BY SUBCOMMUNITY FOR PILOTS AND NFO'S

Subcommunity	Pilots	NFO's
VAL/VFA	$10,000	n/a
VAM	12,000	$0
VF	10,000	4,000
VAQ	12,000	4,000
VS	10,000	0
VQ JET	10,000	0
VP	8,000	0
VQ PROP	8,000	4,000
VQ TAC	8,000	4,000
VAW	10,000	4,000
HSL/HC	7,000	n/a
HS/HM	6,000	n/a

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program* [Ref. 4]

*These annual bonus amounts are multiplied by the number of years an aviator agrees to remain on active duty up to the 14th YOS.

communities have never been offered a bonus before), which may have led to the high forecast errors. Also, the Navy manages aviators on the subcommunity level instead of on the more aggregated jet, propeller, and helocopter community level used in this study and many of the subcommunities are quite small in size. The smaller the cohort the more difficult it is to provide accurate forecasts because of continuation rates the decisions of a small number of individuals can cause a significant forecast error. [Ref. 4:p. 40]

TABLE 7. ACP CONTRACTS ATTAINED AND PREDICTED FOR FOCUS YEAR GROUPS BY SUBCOMMUNITY

Subcommunity	(1) Attained	(2) Predicted	(3) %error
		a. Pilots	
VAL/VFA	22	31	40.9
VAM	17	12	-29.4
VF	9	17	88.9
VAQ	2	3	50.0
VS	8	8	0.0
VP	65	92	41.5
VAW	11	15	36.4
HSL/HC	85	103	21.2
HS/HM	43	64	48.8
		b. NFO's	
VF	25	40	60.0
VAQ	19	35	84.2
VQ	14	20	42.9
VAW	13	26	100.0

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program*

IV. METHODOLOGY AND RESULTS

This chapter explains the use of the STRAP-O model to predict the retention behavior of aviators using the ACP bonus award levels suggested in the CNA study for pilots. [Ref. 4] However, the actual bonus amount awarded NFO's was $6,000/year so this value was used for this study for NFO's. The methodology used in this thesis follows as closely as possible that used in the CNA study. However, it is not the intent of this thesis to redo, validate, or refute the results obtained from the CNA study. The CNA study simply provides a vehicle to exercise the STRAP-O model. The predicted number of bonus takers from the STRAP-O analysis can be compared to those obtained in the CNA study, as well as to actual number of bonus takers for FY 1989.

A. ENVIRONMENT

In order to duplicate the actual manpower environment in 1989, it was necessary to enter into STRAP-O the manpower policy constraints that existed at the end of Fiscal 1988. These policies must be in place to allow the ORFM and OPRO modules to adjust loss rate calculations to reflect the same environment that existed in Fiscal 1988. The environment included the constraints on promotion opportunities, promotion zones, and flow points. The STRAP-O default scenario for 1988 was recalled from the archives at Argonne; in addition, data

obtained from the Officer Personnel Information System (OPIS) and the Fiscal Year 1989 promotion plan were entered into STRAP-O.

1. Promotion Opportunity

The STRAP-O model can use promotion opportunities that it generates itself (in meeting target end strengths) or those entered by the user. Two types of promotion opportunities are needed by STRAP-O. First, the overall promotion opportunities by pay grade must be established. For example, if the promotion opportunity to lieutenant commander (LCDR) is 80 percent, then STRAP-O will promote 80 percent of the total eligible lieutenants (LT) to LCDR. The promotion opportunities, by pay grade, for FY 1989 are shown in Table 8.

TABLE 8. PROMOTION OPPORTUNITIES (PERCENT) BY PAY GRADE

Pay Grade	Promotion Opportunities
LCDR	80
CDR	70
CAPT	55

Source: PERS-21

However, historically, rates of promotion within the various subcommunities have differed from each other. Therefore, promotion rates within the individual communities are needed to run the model. These are entered by the user and are based on the historical (past three years) average promotion experience. For example, the average promotion rate of

jet pilot LT to LCDR, for FY 86-88, was 87.66 percent, while the overall promotion rate was only 80 percent. The subcommunity-specific promotion rates were obtained from OPIS and averaged for FY 86-88. They are listed in Table 9.

TABLE 9. PROMOTION OPPORTUNITIES FOR PILOTS BY SUBCOMMUNITIES (IN %)

Subcommunity	LCDR	CDR	CAPT
PILOTS			
JET	87.7	77.5	57.2
PROP	82.9	69.4	54.2
HELO	83.2	76.3	48.9
NFOs			
JET	81.9	72.9	54.8
PROP	85.2	65.4	49.1

Source: OPIS

2. Flow Points

Other policy variables required by STRAP-O are the desired flow points. A flow point is the expected point in an individual's career at which a particular rank is actually achieved. This determines how quickly personnel flow through the system. Flow points are identical across all subcommunities by paygrade since they are controlled by the Bureau of Naval Personnel. Flow points are expressed in years and months of active service. The flow points entered into STRAP-

O were obtained from the FY 89 promotion plan and are shown in Table 10.

TABLE 10. FY 89 PROMOTION PLAN FLOW POINTS BY PAY GRADE (YEARS-MONTHS)

Pay Grade	Flow Point
LCDR	9-09
CDR	15-02
CAPT	21-01

Source: PERS-21

3. Promotion Zones

The YOS point of athe bottom of a promotion zone determines the number of people who come before a particular promotion board. For the year in question, the promotion zone is defined by the length of active service (years and months) of the most junior eligible personnel. These data were obtained from the FY 89 promotion plan and are shown in Table 11.

TABLE 11. FY 89 PROMOTION PLAN ZONE BOTTOMS (YEARS-MONTHS) BY PAY GRADE

Pay Grade	Zone Bottom
LCDR	8-01
CDR	13-01
CAPT	19-01

Source: PERS-21

B. METHODOLOGY

The methodology employed in using STRAP-O to determine the effects of the ACP program on aviator retention differed from the CNA study in several ways. First, the size of the bonus used to generate the STRAP-O forecasts of NFOs was $6,000 per year (which was the actual award level) not the $4,000 per year suggested in the CNA study. Second, the VS, VQ JET, VQ TAC, and VQ PROP subcommunities were excluded from this study. Because these subcommunities are very small, contain multiple aircraft types or members with very different missions, individuals in these groups are not expected to behave the same across the entire subcommunity.

The STRAP-O forecasting methodology involved the following six-step process:

1. Determine a baseline (no bonus) continuation rate and number of survivors, for each subcommunity, to YOS 8 and YOS 11;

2. Inject the applicable bonus amount, as a percent of base pay, at YOS 6 and forecast the expected change in continuation rates to YOS 7;

3. Calculate the increase in the number of officers predicted to survive to YOS 8 after the bonus is applied;

4. Calculate the difference between the bonus, and no-bonus forecasts, at YOS 8. This is the number of additional officers retained by the ACP bonus;

5. Add these additional officers to the no-bonus stock of personnel at YOS 11;

6. Compare the STRAP-O and CNA projections, and then compare both of these to the actual number of bonus takers in 1989.

1. Baseline Forecasts

An initial, baseline forecast was made with STRAP-O that assumes no changes in pay. From this, the cumulative continuation rates from YOS 6 (the approximate end of the initial obligation) to YOS 8 and YOS 11 for each of the five aviation subcommunities in STRAP-O (pilot jet/prop/helo and NFO jet/prop) were determined. These continuation rates were then applied to the average annual inventories, for each community listed in Table 2 for year groups 1982-1984. The baseline (no-bonus) stocks of personnel at YOS 8 and YOS 11 determined by this process are shown in Table 12.

TABLE 12. BASELINE STOCKS OF PERSONNEL PREDICTED BY STRAP-O AT YOS 8 AND 11 FOR EACH COMMUNITY (FOR TARGET YEAR GROUPS 1982-1984

	Forecasted No-Bonus Stocks	
Community	YOS 8	YOS 11
PILOTS		
VAL/VFA	58	28
VAM	26	12
VF	40	19
VAQ	10	5
VP	60	34
VAW	16	9
HS/HM	56	36
HSL/HC	134	86
NFOs		
VAQ	40	26
VF	56	37
VAW	34	23

Source: Author

2. Applying the Bonus

STRAP-O does not allow the direct application of a one-time lump sum monetary payment. All changes in pecuniary benefits must be in terms of a percent change in base pay. Therefore, the Net Present Value (NPV) of the bonus, discounted at 10 percent, was converted to a percentage of base pay and applied at YOS 6. The following payment stream was used to calculate the NPV of the ACP bonus for an NFO:

> Assume NFOs have 6 years of active duty (Pilots 6.5 years since pilots have a longer training period) when they become eligible for the ACP program and accept the 50% lump sum bonus option (The other payment option is to accept the bonus amount every year, i.e., 6,000/year for seven years). At $6,000/year this equates to a payment stream of $21,000 in the first year and $3,500/year for each of the next 6 years. This payment stream, discounted at 10 percent, has a NPV of $36,243 at the start of the obligation period.

$$NPV = 36,243 = \$21000 + \sum_{N=1}^{6} (\$3.500/1.1SUPn)$$

The base pay figure was determined for an O-3 (LT) with over 6 years of active service, including flight pay. Using the pay scales in effect 1 JAN 89 this yielded a total base pay of $29,608.

Thus with the NPV of the bonus, the pilot's equivalent pay for the first year of the bonus contract would be $29,608 + $36,243 = $65,851. This represents a 122% pay increase for this year.

The NPV of the bonus is applied as a one-time payment because once the decision is made to accept the bonus, the bonus taker is obligated through YOS 14. The decision to

accept the bonus must be made at the value of the bonus when it is accepted. The no-bonus continuation rates from YOS 6 to YOS 8 and YOS 11, and the continuation rates from YOS 6 to YOS 8 with the bonus are listed in Table 13. The listings are in terms of pilots (JET, PROP, HELO) and NFOs (JET, PROP). As can be seen in Table 13, the large bonus payments have driven the continuation rates to 1.00 except for HELO pilots and JET NFOs. Note that there were two different bonus levels in the jet pilot and helicopter pilot subcommunities, depending on specific aircraft type.

3. Bonus Takers

The term bonus takers includes those personnel who remain due to the bonus, as well as, those personnel who would have stayed without the bonus. This thesis makes the assumption that anyone intending to remain in the service through their department head tour will take the bonus. Given this assumption, the number of actual bonus takers will represent, fairly well, the stocks of available personnel to fill department head billets. People who do not take a bonus or who take a short-term bonus are not expected to be available for department head tours.

Since the decision to accept the bonus can be made only once, the increase in the continuation rate through YOS 7 determines the additional personnel retained as a result of the ACP bonus. Therefore, the number of additional personnel who survive through YOS 7 to arrive at YOS 8 are the

additional bonus takers retained by the ACP bonus. This is calculated by taking the difference between the bonus and no-bonus forecasts of personnel stocks at YOS 8. Table 14 shows the forecasted number of bonus takers.

TABLE 13. NO-BONUS AND BONUS CONTINUATION RATES FORECASTED BY STRAP-O FOR PILOTS AND NFOs

Bonus amount by Subcommunity	No-Bonus		Bonus
	YOS 8	YOS 11	YOS 8
JET PILOT	.7134	.3402	
$12,000			1.00
10,000			1.00
PROP PILOT	.5709	.3189	
8,000			1.00
HELO PILOT	.8661	.5542	
7,000			.9901
6,000			.9891
JET NFO	.8971	.5911	
6,000			.9886
PROP NFO	.8842	.5895	
6,000			1.00

Source: Author

TABLE 14. PREDICTED ADDITIONAL PERSONNEL RETAINED DUE TO THE ACP BONUS (USING STRAP-O)

Community	Forecasted Bonus Takers	% Increase over YOS 11 baseline
PILOTS		
VAL/VFA	23	82
VAM	10	91
VF	19	80
VAQ	4	80
VP	45	132
VAW	12	133
HS/HM	8	22
HSL/HC	19	22
NFOs		
VAQ	4	15
VF	6	16
VAW	4	17

Source: Author

C. REQUIREMENTS VS. FORECASTS

The forecasted number of additional bonus takers are added to the no-bonus forecast of the YOS 11 stocks of personnel. This becomes the pool of available personnel to fill department head billets, starting around YOS 11. Table 15 shows the pool of available personnel to fill department head billets as forecasted by STRAP-O, and by the CNA study; the actual number of bonus takers through 1989; and the actual requirements from the Manpower and Training branch of the Assistant Chief of Naval Operations (Air Warfare, N-889).

TABLE 15. PREDICTED STOCKS OF AVAILABLE PERSONNEL AT YOS 11 COMPARED TO ACTUAL 1989 BONUS TAKERS AND REQUIREMENTS

a. PILOTS

Community	FORECASTS		ACTUAL	
	STRAP-O (% err)	CNA (%err)	Takers	Requirements
VAL/VFA	51 (152)	31 (41)	22	53
VAM	23 (35)	12 (-29)	17	22
VF	36 (300)	17 (89)	9	33
VAQ	9 (50)	3 (50)	2	11
VP	79 (22)	92 (42)	65	99
VAW	21 (91)	15 (36)	11	13
HS/HM	44 (2)	64 (49)	43	52
HSL/HC	105 (24)	103 (21)	85	121

b. NFOs

Community	FORECASTS		ACTUAL	
	STRAP-O (% err)	CNA (% err)	Takers	Requirements
VAQ	31 (24)	35 (40)	25	33
VF	43 (231)	40 (208)	13	40
VAW	27 (42)	26 (37)	19	25

Source: Author

D. AN EXAMPLE: VAQ NFOs

The following is an example of the results of this methodology applied to VAQ NFOs for the target year groups 1982-1984:

- The baseline continuation rates to YOS 8 and 11 estimated by STRAP-O are .8971 and .5911, respectively. These continuation rates are applied to the average annual inventory obtained from Table 2 of 44.7 VAQ NFOs in the target year groups. From this average 40.1 NFOs survive to YOS 8 and 26.42 NFOs survive to YOS 11 in the baseline case.

- The NPV of the award level for VAQ NFOs is $36,243 and this equates to a 122 percent increase in basepay. This increase is applied at YOS 6 and the retention rate to YOS 8 is forecasted by STRAP-O to be .9886. Therefore, the forecasted number of survivors to YOS 8 are 44.19.

- The difference between the forecasted, bonus and no-bonus stock at YOS 8 is 4.09.

- These additional survivors are then added to the no-bonus YOS 11 stock to yield 30.51 officers. This is the pool of VAQ NFOs, forecasted by STRAP-O, available to meet department head requirements, from the target year groups due to the ACP bonus.

- This forecasted pool of personnel are then compared to the annual requirements, tc determine if a shortfall exists. The annual requirement for VAQ NFOs is 32.9, yielding a forecasted shortfall of 1.79. The actual shortfall is 8 NFOs (Actual takers minus requirements) as shown in Table 15.

E. RESULTS

For pilots, as shown in Table 15, the forecasted pool of available personnel at YOS 11 was overestimated by both STRAP-O and the CNA study in almost all cases compared to the actual number of bonus takers. However, although the CNA study overestimated the actual stock, CNA concluded that the shortfall of personnel would remain in all communities with the suggested ACP bonus award levels. The forecasts that STRAP-O makes for pilots indicate that for the majority of subcommunities requirements will be met with the suggested bonus award levels. The conclusions drawn from the STRAP-O predictions would lead policy makers in many cases to <u>decrease</u> the bonus amounts, exacerbating the shortages.

For NFOs, the predictions from STRAP-O and the CNA study were essentially similar. The predictions overestimated the

stock and predicted that there would be no shortages. It was noted in the CNA study, however, that very little was known concerning the pay elasticity for NFOs and it was expected that the bonus would have very little effect on the retention rates of these personnel.

CNA's estimates of retention had smaller errors than the STRAP-O estimates due to more recent data as well as data that was taken directly from a current bonus environment. The econometric parameters in STRAP-O were not derived to forecast the effects of a large, one-time, bonus payment. Also, as can be seen from the large variation in percentage error between subcommunities, large differences in behavior between communities lead to the conclusion that aggregating all aviators by jet, prop, or helo does not make a good substitute for making separate forecasts proxy for the small population subcommunities. The small cohort size of each subcommunity has caused significant error in the forecasts.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This thesis addressed the issue of the Aviation bonus and its effects on retention simply as a vehicle to exercise STRAP-O on a real world, tactical problem. It was not the intention of this study to redo, validate, or refute the results obtained in CNA's study, Implementation of the Aviation Continuation Pay (ACP) Program. This thesis makes a comparison between STRAP-O forecasts, an independent study and real world results. These results are contained in the Table 15. The STRAP-O forecast's show large errors for VF NFO's and all Jet Pilot communities except for VAM. STRAP-O treats all Jet Pilots as one community and all Jet NFO's as one community, but the varying error rates show that communities behave independently. It could also be concluded from these results that VAM pilots are more satisfied with their community than other Jet Pilots and VF NFO's less satisfied than other Jet NFO's with their communities.

In general the stocks of available personnel to fill department head billets are overestimated by the STRAP-O model. For NFO's, STRAP-O and CNA compare well with each other but grossly overestimate the actual number of NFO bonus takers. For pilots, the STRAP-O estimates of the numbers of bonus takers are much higher than the CNA estimates, except in

the case of VP pilots. However, compared with the actual bonus takers both sets of estimates are too high.

The predictions of STRAP-O substantially overestimate the actual aviation continuation rates. The main reason for this is the long period of time that has elapsed since the econometric parameters of the ORFM module of STRAP-O have been updated. These parameters have not been updated since 1984. This module is not employed in practice and according to NPRDC this study is the first time OFRM has been used in an actual application. This study has found the parameters to be so inaccurate that ORFM was unable to provide reliable estimates of the effect of pay changes on the continuation rates for the aviation sub-communities of pilots (jet/prop/helo) and NFO's (jet/prop). However, in all fairness, the magnitude of some of the pay changes are well beyond the sensitivity intended in the original design of STRAP-O. This is why the STRAP-O estimates of retention rates where driven to 1.0 for pilots (JET/PROP) and .9886 for NFOs (JET). With these high retention rates almost the total beginning inventory of Jet NFO's and the entire beginning inventory of Jet Pilots were expected to accept the ACP bonus and remain in service, but this was not borne out by the real world experience.

The Officer Goals (OGOALS) module is currently inoperative, so strength targets are manually entered into a default scenario. It is not known if the OGOALS module has ever been employed.

The Accessions Into Designators (AIDS) module has never been applied to real a world problem. It has only been used in demonstrations and there are few outside of NPRDC who even know what AIDS does.

OGOALS has fallen into disarray because of lack of use. AIDS is not used and ORFM has not been updated because there has been no demand for it. This lack of use is why Navy has a strategic planning model that is employed using only one of its four modules.

OPRO used in this solo fashion is strictly a naive forecasting tool. It has no ability to adjust for external economic factors nor for varying internal strength targets.

B. RECOMMENDATIONS

As a long range strategic planning tool, STRAP-O can provide the policy maker with a method of examining various policy alternatives for their future implications. However, in today's rapidly changing, uncertain manpower world, strategic planning often gives way to tactical planning. The following recommendations are provided in an attempt to increase the use of STRAP-O by Navy manpower planners:

1. Usability

STRAP-O must provide manpower planners with a tool that provides answers to the questions they must ask. Without the ability to make forecasts for periods of less than one year and a data base that is updated at least monthly, STRAP-O will continue to be under-utilized or completely ignored.

The difficulty of entering data into STRAP-O is one major reason for its lack of use. Because it resides on a main frame computer many potential users are intimidated. The current front end of STRAP-O requires the user to move through the main frame environment to update plans and input the policy changes being examined. For example, at the start of this study the pay change pages in the Officer Retention Forecasting Module (ORFM) could not be used. There are 9 pages of pay changes (pages 200-208) that can be entered (up to 9 different pay changes can be input per run). However, the way the source code was written, if page 200 was not activated then no other page was read by the program. The contractor fixed this problem and said that they had no idea why the code was written that way. After the contractor modified the program, only page 200 would work. It was decided to leave the program alone at this point since with one page the model runs could be accomplished one at a time. Problems like this are frustrating, which lead novice computer users to find other means to solve their problems.

STRAP-O output is also very unwieldy. For a model designed to allow the user to quickly evaluate a series of "what if" questions, a large amount of paper is generated. In the course of this study a stack of paper over a foot and a half high was created. Each run produces a set of output three quarters of an inch thick. However, the few numbers required from each run are all contained on one page. The

user should have some control over the amount of output. This would be especially important in a PC version of STRAP-O that is not linked to a speedy, high volume laser printer.

It has been suggested that STRAP-O be disaggregated to allow separate runs for specific communities. This defeats the whole purpose of the STRAP-O model. Since the Navy manpower pie is fixed by DOPMA restrictions, no community can be altered without having some implications for other communities. The current model configuration provides the means to keep tabs on what happens to the whole Navy plan as individual community problems are addressed.

Another serious problem is that the data base used by STRAP-O must be updated more frequently then once a year. Without very accurate personnel stocks, budgetary estimates could be substantially inaccurate and this could cause serious problems at the end of the fiscal year. For this reason at least a quarterly update is required, and a monthly update would be ideal.

2. Develop a PC Version of STRAP-O

Presently the idea of creating a PC version of STRAP-O is being discussed in BUPERS. The STRAP-O model consists of 10,000 lines of code. With the advent of the 486 computer chip, a program of this size could easily be accommodated. A PC-version would make real time analysis of policy questions a reality. This would also allow for greater exploration of the tactical options STRAP-O may be able to provide.

In the process of moving STRAP-O to the PC, a user-friendly menu system must be designed which allows a user with no computer knowledge to setup and run the model and to interpret the output. If the functions of STRAP-O that are not presently being used continue to lie dormant, they should not be incorporated into the PC-version of the model. Specifically, since the accession process for officers has such a long lead time (4 years), is there really a need for an accession source planning module (i.e., AIDS)?

Currently, the Navy Officer Personnel Planning System (NOPPS) is the tool relied upon to deal with both the tactical and the strategic issues faced by the Officer Plans and Career Management Division (PERS-21). STRAP-O and NOPPS used together could be very effective as a team but the two models must be designed to interact. Unless STRAP-O can demonstrate a tactical application, NOPPS will continue to be the tool used to solve short term problems. The potential long range problems from these short term solutions may not be expected or planned for. If a PC version of STRAP-O cannot interact with NOPPS, PC STRAP-O will again find itself in disuse.

APPENDIX A

STRAP-O OFFICER COMMUNITIES

URL Communities

GURL	(General Unrestricted Line)
SURFACE	
NUC SURF	(Nuclear Surface)
NUC SUB	(Nuclear Submarine)
GEN SUB	(General Submarine)
SPEC WAR	(Special Warfare)
SPEC OPS	(Special Operations)
GEN AVIATION	(General Aviation)
JET PILOT	
PROP PILOT	
HELO PILOT	
JET NFO	
PROP NFO	

RL Communities

EDO	(Engineering Duty Officer)
AEDO	(Aviation Engineering Duty Officer)
AMDO	(Aviation Maintenance Duty Officer)
CRYPTO	
INTELL	
PUB INFO	(Public Affairs Information Officer)
OCEANO	(Oceanographic Officer)
MEDICAL	
DENTAL	
MED SERV	(Medical Service Officer)
JAG	(Judge Advocate General)
NURSE	
SUPPLY	
CHAPLAIN	
CEC	(Civil Engineering Corps)
LDO LINE	(Limited Duty Officer Line)
LDO SUPPLY	(Limited Duty Officer Supply)
LDO CEC	(Limited Duty Officer CEC)

APPENDIX B

SUBCOMMUNITY AND AIRCRAFT TYPE

Subcommunity	Aircraft Type
VAL/VFA	A-7, AV-8, F/A-18, F-16
VAM	A-6, A-12
VF	F-4, F-5, F-8, F-14
VAQ	EA-6, EA-6B
VS	S-3A, S-3B
VQ JET	EA-3
VP	P-3A/B, P-3C, VXP
VQ PROP	EP-3
VQ TAC	E-6A, EC-130
VAW	E-2A/B, E-2C
HS	SH-3
HSL2	SH-2
HSL60	SH-60F, SH-60B
HC	U/HH-3, E/U/HH-46, CH-53E
HM	R/MH-53D/E, CH-53

Source: *Adapted from *Implementation of the Aviation Continuation Pay (ACP) Program*

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